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Interactive Mobile Learning: Developing and Evaluating an Android-Based Monopoly Game for Enhancing Engagement and Learning Outcomes in Elementary School

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ABSTRACT

Objective: To address the persistent challenges of low engagement and poor outcomes in elementary social studies instruction. This study aimed to develop an Android-based Monopoly game and examine its effects on fourth-grade students' engagement and learning outcomes regarding Indonesian Cultural Diversity. **Method:** A Research and Development approach was integrated with a quasi-experimental nonequivalent control group pretest–posttest design involving 62 fourth-grade students (experimental: n = 32; control: n = 30) from two public elementary schools in Central Java. Data collected through validated engagement questionnaires and cognitive achievement tests were analyzed using one-way ANCOVA (with pretest as covariate), independent samples t-tests, N-gain, and Cohen's d. **Results:** Expert validations confirmed the media's feasibility as 'Very Feasible' (88.02%, ICC = 0.882). ANCOVA results demonstrated that the experimental group achieved significantly higher posttest scores than the control group after controlling for pretest scores ($F(1, 59) = 6.12$, $p = 0.016$, $\eta^2p = 0.094$), supported by a larger N-gain (0.38 vs. 0.29) and a medium effect size ($d = 0.58$). Furthermore, experimental students reported meaningfully higher behavioral, emotional, and cognitive engagement ($d = 0.65$). **Novelty:** This study provides empirical evidence on the synergistic potential of combining gamification mechanics with mobile platforms for culturally specific content. It demonstrates how interactive game-based pedagogy can successfully operationalize the student-centered principles of the Kurikulum Merdeka framework, specifically addressing the lack of technology-enhanced media in the integrated IPAS (Ilmu Pengetahuan Alam dan Sosial) curriculum.

INTRODUCTION

Technological advancements have redefined global education, making technology-integrated teaching and learning crucial for 21st-century elementary school students (Dorris et al., 2024; Topkaya et al., 2025). At the same time, Indonesia's Independent Curriculum (*Kurikulum Merdeka*) introduced student-centered reforms, most notably combining elementary school science and social studies into a single, holistic subject, which is called the Social and Natural Sciences (IPAS) (Kemendikbudristek, 2024; Meriza et al., 2024). Despite these pedagogical and structural innovations, teachers still face persistent challenges in implementing engaging and meaningful teaching and learning, particularly regarding the dense social science (IPS) content within the social and natural science (IPAS) subjects, which must share limited teaching time (Fatmawati et al., 2024; Hanum et al., 2024).

The social sciences content within the Natural Sciences (IPAS) curriculum is highly relevant for preparing responsible Indonesian citizens (Rahayu et al., 2025). However, its implementation continues to be hampered by conventional memorization-heavy learning and the minimal use of instructional media in the classroom by teachers and students (Rasimin et al., 2024). While curriculum reforms are a necessary step forward,

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they do not magically erase deep-rooted pedagogical challenges. The demand for more effective teaching media remains urgent. A preliminary study at one of elementary schools in Purworejo gives the evident, which is showed that 56% of fourth-graders could not pass the minimum criteria (KKTP = 65) for the Indonesian Cultural Diversity module. The study also reveals that this high failure rate stems from outdated instructional practices. Teachers still rely heavily on static images and rarely utilize available mobile devices. It makes students disengaged when dealing with text-heavy materials.

Choosing an appropriate instructional media directly impacts teaching quality (Nzilano & Machumu, 2025; Smaldino et al., 2019). As Dale's Cone of Experience suggests, students absorb information better when instruction shifts from abstract concepts to concrete, hands-on activities (Dale, 1969; Davis & Summers, 2015). In this context, mobile learning which is using smartphones or tablets in the learning process, provides a highly practical solution (Aldeeb et al., 2024; Meekaew & Ketpichainarong, 2021). This approach is effective in enhancing motivation, engagement, and academic achievement. It has highly relevant prospects for elementary education given its interactive multimedia environment in accordance with the characteristics of children's cognitive development (Criollo-C et al., 2024; Crompton et al., 2019).

Gamification has proven to be a highly effective strategy to keep students engaged (J. Chen & Mokmin, 2024; Wulansari et al., 2024). A recent meta-analysis by Zeng et al. showed a moderate positive effect of gamification on academic achievement (Hedges's g = 0.782, $p < 0.05$) across levels from primary to secondary education (Zeng et al., 2024). The integration of this approach into instructional design has been shown to improve problem-solving and critical thinking (Dehghanzadeh et al., 2024; Pujiastuti et al., 2025). Modified board games such as Monopoly demonstrate substantial pedagogical efficacy. Their underlying mechanisms, encompassing strategic planning, resource management, and social dynamics, are highly congruent with established curricular objectives (Adika et al., 2023; Nurhayati et al., 2022). In addition, children's familiarity with Monopoly reduces the cognitive learning curve (Chang et al., 2017). Thus facilitating the acceleration of direct engagement with the material substance (Jhang et al., 2025).

The widespread use of smartphones in Indonesia presents a massive opportunity to bring game-based learning into elementary classrooms (Dewi & Winanto, 2025; Sukasmi et al., 2022). Transforming a traditional game like Monopoly into an Android application offers several benefits. It offers interactive multimedia integration. As an Android app, it can offer instructional videos, animated feedback, and automated assessments, so facilitating instant cognitive reinforcement (Alenezi & Amir, 2023; Jaleel & Alansari, 2024). Previous studies confirm that the Android-based Monopoly consistently improves elementary school students' problem-solving, and conceptual understanding (Adika et al., 2023; Nurhayati et al., 2022). These findings suggest that adaptation of Monopoly to the Android platform is a strategic solution to tackle engagement deficits and low learning outcomes in the social sciences (IPAS).

Mobile learning and game-based approaches are well-supported independently. However, there remains a notable gap in the literature regarding the systematic integration of Android-based Monopoly games, which are specifically designed for the social sciences strand of elementary IPAS instruction. Most existing studies have focused on either conventional board game adaptations or general mobile learning applications . They are not fully exploring the synergistic potential of combining gamification

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mechanics with mobile platform affordances for culturally specific content such as Indonesian Cultural Diversity (Mansor et al., 2024; Sujarwo et al., 2023). Despite the proven benefits of Monopoly, three specific limitations of existing mobile-Monopoly applications render them insufficient for delivering culturally specific content such as Indonesian Cultural Diversity. First, prior digital adaptations have been overwhelmingly developed for arithmetic, financial literacy, or general vocabulary practice (Adika et al., 2023; Nurhayati et al., 2022), reducing the Monopoly board to a generic framework for delivering questions. This approach ignores the rich cultural artefacts (including regional dances, traditional houses, musical instruments, and costumes) that are central to the IPAS social sciences strand. Second, available mobile Monopoly apps rarely embed locally produced multimedia (e.g., authentic cultural videos, region-specific audio, and Indonesian-language narration), so they cannot operationalise the multisensory immersion that Dale's Cone of Experience identifies as essential for concept formation in concrete-operational learners (Dale, 1969; Davis & Summers, 2015). Third, to the best of our knowledge, no publicly documented mobile Monopoly tool has been explicitly aligned with the Phase B Learning Outcomes of the *Kurikulum Merdeka* IPAS curriculum, leaving Indonesian fourth-grade teachers without a curriculum-coherent, technology-enhanced option for the Indonesian Cultural Diversity module (Mansour et al., 2024; Sujarwo et al., 2023). Consequently, existing research on educational media based on Monopoly predominantly deploys physical board games, which restricts accessibility, scalability, and multimedia integration. Ruiz et al., in a systematic review published in Frontiers in Education, confirmed that gamification research in primary education remains underexplored compared to higher education settings, and called for more empirical studies evaluating game-based interventions in authentic classroom environments across diverse subject domains (Ruiz et al., 2024). The integration of IPA and IPS into a single IPAS subject under *Kurikulum Merdeka* further intensifies this need: the social sciences strand now competes for instructional time and pedagogical attention within a broader integrated subject, making the development of engaging, efficient, and technology-enhanced media for social sciences content more urgent than ever. This gap underscores the need for rigorous investigation into the design, feasibility, and effectiveness of Android-based interactive Monopoly games as instructional tools for IPAS social sciences content in elementary education.

Drawing the foregoing arguments to a focused statement, this study moves from the *general* premise that 21st-century elementary instruction must integrate technology and learner-centred pedagogy (Dorris et al., 2024; Topkaya et al., 2025) to the *specific* problem that the social sciences strand of the *Kurikulum Merdeka* IPAS subject continues to suffer from low engagement, dense content, limited instructional time, and the under-utilisation of mobile devices for culturally specific learning (Fatmawati et al., 2024; Hanum et al., 2024; Rasimin et al., 2024). Prior digital adaptations of Monopoly have predominantly served numerical or generic-vocabulary content (Adika et al., 2023; Nurhayati et al., 2022), have rarely embedded locally produced multimedia capable of operationalising Dale's Cone of Experience for concrete-operational learners (Dale, 1969; Davis & Summers, 2015), and have not been demonstrably aligned with the Phase B Learning Outcomes of the IPAS curriculum (Mansor et al., 2024; Sujarwo et al., 2023). Against this backdrop, the present study differentiates itself from prior literature on three specific axes: (1) its cultural-content specificity, embedding authentic regional dances, traditional houses, costumes, and musical instruments as multimedia tiles rather than as

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generic question fillers; (2) its explicit alignment with Phase B Learning Outcomes of the *Kurikulum Merdeka* IPAS curriculum, providing the first publicly documented mobile-Monopoly tool calibrated to this national curricular framework; and (3) its concurrent dual-outcome evaluation, in which a three-dimensional engagement measure (behavioural, emotional, cognitive) and a pretest-controlled cognitive achievement test are analysed within a single quasi-experimental design situated in authentic Indonesian classrooms. From this specifically delineated niche, the four research objectives of the present study are derived.

This study addresses the identified gap by developing and evaluating an Android-based Monopoly game as interactive mobile learning media for fourth-grade IPAS instruction on the social sciences topic of Indonesian Cultural Diversity. This study employs an R&D approach integrated with a quasi-experimental design involving two elementary schools in Purworejo Regency, Central Java. The study aims to achieve four objectives: (1) to design the Android-based Monopoly game media that integrates multimedia content on Indonesian Cultural Diversity; (2) to assess the validity and feasibility of the developed media; (3) to compare student engagement across behavioral, emotional, and cognitive dimensions between students using the game and those receiving conventional instruction; and (4) to evaluate the effectiveness of the media in improving student learning outcomes compared to conventional instruction. This study aims to provide a practical, evidence-based media for the *Kurikulum Merdeka*. By combining mobile technology with gamification, we offer teachers a concrete strategy to enhance both student engagement and academic achievement in the IPAS subject.

RESEARCH METHOD

General Description

This study employed a quasi-experimental research design with a nonequivalent control group pretest–posttest configuration to investigate the effectiveness of an Android-based Monopoly game as interactive mobile learning media to enhance student engagement and learning outcomes in elementary social studies education. The quasi-experimental design was selected because random assignment of individual participants was not feasible in authentic school settings; instead, intact classroom groups were assigned to experimental and control conditions (Creswell & Creswell, 2017). This design enabled the researchers to compare both engagement levels and learning outcomes between two naturally formed groups while controlling for initial differences through pretest measurement. The independent variable was the instructional media, specifically the Monopoly game on Android for the experimental group and conventional instruction for the control group (operationally defined in the Experimental Phase subsection of the Procedures). Two dependent variables were measured: (1) student engagement, operationally defined as the degree of behavioral, emotional, and cognitive involvement during the learning process (Fredricks et al., 2004); and (2) learning outcomes, measured through cognitive achievement on the topic of Indonesian Cultural Diversity (Keragaman Budaya Indonesia), which is taught within the Social Sciences content of the *Ilmu Pengetahuan Alam dan Sosial* (IPAS) subject in the *Kurikulum Merdeka* framework for fourth-grade elementary students. The study was conducted during the even semester of the 2024/2025 academic year in Grabag Sub-district, Purworejo Regency, Central Java, Indonesia. The research design is illustrated in Table 1.

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Table 1. Quasi-Experimental Nonequivalent Control Group Pretest–Posttest Design

Group	Pretest	Treatment	Posttest
Experimental (School A)	O_1	X	O_2
Control (School B)	O_3	–	O_4

Note: O_1, O_3 = pretest scores; X = treatment (Android-based Monopoly game); O_2, O_4 = posttest scores; – = conventional instruction.

Participants

The participants were 62 fourth-grade students from two public elementary schools in Grabag Sub-district, Purworejo Regency, Central Java, Indonesia. The experimental group comprised 32 students (13 males, 19 females) from School A, while the control group consisted of 30 (14 males, 16 females) students from School B. Both schools were purposively selected based on the following criteria: identical curriculum implementation (*Kurikulum Merdeka*), comparable socioeconomic backgrounds, equivalent class sizes, similar baseline academic performance in social studies as indicated by prior semester records, and geographical proximity within the same sub-district (Creswell & Creswell, 2017). Prior to the main experiment, instrument validation was conducted with 27 fifth-grade students from School A who were not participants in the main study. A small-scale trial involved 8 purposively selected fourth-grade students from a parallel class (Class B) at School A, who were not participants in the main experiment, to evaluate media usability. All participants' parents or guardians provided informed consent. The demographic characteristics are presented in Table 2.

Table 2. Demographic Characteristics of Participants

Characteristic	Experimental Group	Control Group
Number of students	32	30
Male / Female	13 / 19	14 / 16
Age range (years)	9–11	9–11
Grade level	4th grade	4th grade

Instrument

Learning Outcomes Test

The primary instrument for measuring learning outcomes was a cognitive achievement test on the topic of Indonesian Cultural Diversity, aligned with the Learning Outcomes (Capaian Pembelajaran / CP) for Phase B (Grades 3–4) of the IPAS subject under the *Kurikulum Merdeka* framework, specifically the social sciences strand addressing Indonesian Cultural Diversity. The test consisted of 40 multiple-choice items. It was developed according to Bloom's Revised Taxonomy (Anderson & Krathwohl, 2001). The test instrument was validated by expert judgment for its content. Then construct validity was evaluated via item analysis, showing a point-biserial correlation that met the required threshold (r_{table} = 0.381 at α = 0.05). The test also showed "very high" reliability, with a KR-20 coefficient of 0.904. The blueprint of the test is presented in Table 3.

Table 3. Blueprint of the Learning Outcomes Test Instrument

Nu	Indicator	C1	C2	C3	C4	C5
1	Explaining factors of Indonesian cultural diversity	✓	✓	-	-	-
2	Differentiating traditional costumes across regions	-	✓	✓	-	-
3	Analyzing forms of traditional houses in Indonesia	-	-	-	✓	-
4	Classifying regional dances across Indonesia	-	-	✓	✓	-
5	Determining regional musical instruments	✓	-	✓	-	-
6	Identifying benefits of cultural diversity	-	✓	-		✓
7	Concluding ways to preserve regional cultures	-	-	-	✓	✓

Note: C1 = Remembering; C2 = Understanding; C3 = Applying; C4 = Analyzing; C5 = Evaluating.

Student Engagement Questionnaire

To measure the student engagement, a structured student engagement questionnaire was developed based on the three-dimensional engagement framework proposed by (Fredricks et al., 2004). The instrument conceptualizes engagement as comprising behavioral, emotional, and cognitive dimensions. This tripartite framework has been extensively validated in elementary education contexts (Appleton et al., 2006; Carter et al., 2012). It is still widely recognized as the most comprehensive approach to measuring student engagement in classroom settings. The questionnaire consisted of 20 items rated on a 4-point Likert scale (1 = Never, 2 = Sometimes, 3 = Often, 4 = Always). The questionnaire was administered to both groups following the instructional intervention. Content validity was established through expert judgment, and internal consistency reliability was assessed using Cronbach's alpha. The engagement questionnaire was administered only at posttest, as engagement is theoretically conceptualized as a context-dependent state reflecting responses to specific instructional conditions rather than a stable trait (Fredricks et al., 2004; Sinatra et al., 2015). Pre-testing items referencing unexperienced learning activities would lack face validity and confuse elementary-age respondents. Baseline group equivalence was established through pretest comparison on learning outcomes. The blueprint of the engagement questionnaire is presented in Table 4.

Table 4. Blueprint of the Student Engagement Questionnaire

Nu	Dimension	Indicator	Items	Total
1	Behavioral Engagement	a. Active participation in learning activities b. Adherence to classroom rules and instructions c. Effort and persistence in completing tasks	1–7	7
2	Emotional Engagement	a. Interest and enthusiasm toward learning b. Enjoyment and positive affect during lessons c. Sense of belonging and connection to learning	8–14	7
3	Cognitive Engagement	a. Use of learning strategies and self-regulation b. Willingness to go beyond basic requirements c. Investment in understanding and mastering content	15–20	6
	Total			**20**

Source: Adapted from (Appleton et al., 2006; Fredricks et al., 2004).

Supporting Instruments

Additional non-test instruments included: (1) a structured interview guide for fourth-grade teachers to identify instructional challenges and media utilization patterns; (2) needs analysis questionnaires for teachers and students to inform media design; (3) expert validation questionnaires on a 4-point Likert scale covering alignment with competency standards, ease of use, developmental suitability, and visual design appeal (Lee & Owens, 2004; Purwanto, 2017); and (4) teacher and student response questionnaires to evaluate user perceptions of the developed media. Document analysis of students' prior academic records was also conducted to establish baseline performance.

Procedures

The research procedures followed an adapted Borg and Gall R&D model (Gall et al., 2007) integrated with the quasi-experimental design, implemented in three sequential phases. In the **development phase**, preliminary research at School A during the previous

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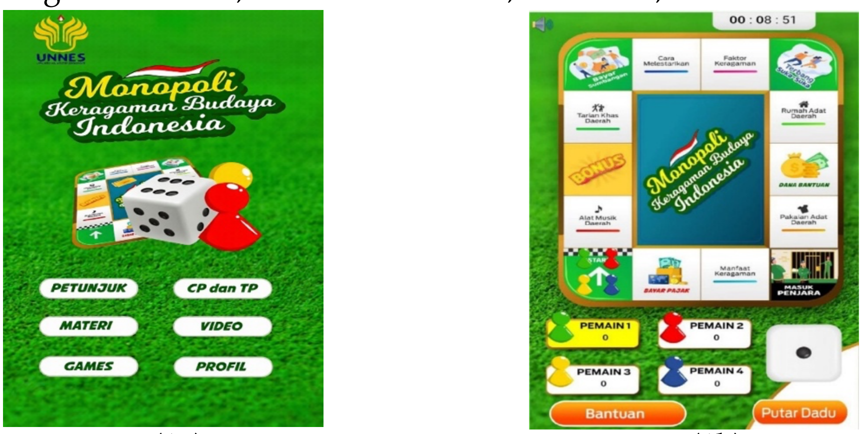
academic year identified that 56% of fourth-grade students (15 out of 27) scored below the minimum competency criteria (KKTP = 65) in social studies, with instructional media limited to static textbook images without technology integration. Based on needs analysis data, the Android-based Monopoly game was developed using Construct 3 as the primary game engine. In addition, Canva and Figma were used for graphic asset design. The HTML5-based game was then converted into an Android application package (.apk) using Apache Cordova. The game incorporated multimedia instructional content on Indonesian Cultural Diversity. It includes text, images, educational videos, and interactive quiz questions. All of them are embedded within the Monopoly board game mechanics. The app operated offline on Android devices with minimum version Android 8.0 (Oreo). It was designed for group-based collaborative play of three to four students per device. To illustrate these design choices, Figure 1 below presents two representative screens of the developed application: (1a) the main menu, which serves as the entry point and learning-objective preview, and (1b) the interactive digital board, which renders the Monopoly mechanics enriched with culturally-specific multimedia tiles representing Indonesian regional dances, traditional houses, costumes, and musical instruments.



(1a) (1b)

Figure 1. The user interface of the Android-based Monopoly game: (1a) the main menu; (1b) the interactive digital board display.

In the **validation phase**, three independent experts evaluated the Android-based Monopoly game. A media design expert, with master's degree in educational technology, assessed technical quality. Second, a subject matter expert, with master's degree in Social Studies, evaluated content accuracy and curriculum alignment. Third, an elementary school practitioner assessed the game's practical feasibility for classroom implementation. Each validator independently completed a structured instrument. The insturment rated on a 4-point Likert scale (1 = Very Poor, 2 = Poor, 3 = Good, 4 = Very Good). Feasibility was classified following Purwanto's criteria (Purwanto, 2017) and inter-rater reliability was assessed using the Intraclass Correlation Coefficient. Revisions were made based on expert feedback, and a small-scale trial with eight students. The complete validation results are presented in the Results section.

In the **experimental phase**, both groups completed a pretest on Indonesian Cultural Diversity. The experimental group received four sessions of instruction using the Android-based Monopoly game. Students collaboratively played in small groups. They play with dice-rolling mechanics, question tiles, and point-based reward systems. The control group received four conventional instruction sessions matched to the

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experimental group regarding content scope, instructional duration, and Phase B Learning Outcomes. These sessions followed a fixed four-stage structure: 1) an opening to activate prior knowledge; 2) direct instruction utilizing the official IPAS textbook alongside static visual aids; 3) textbook-based class discussions; and 4) individual exercises. The instruction strictly excluded all electronic devices, multimedia integration, and gamified collaborative activities. Because both teachers utilized identical pedagogical guidelines and sequence documents, the sole deliberate variation between the conditions was the implementation of the Android-based Monopoly game. Both groups were taught by their respective classroom teachers. The teaching materials covers identical curriculum content aligned with the Phase B Learning Outcomes for the IPAS. Following the intervention, both groups completed the posttest and the student engagement questionnaire.

Data Analysis

Data analysis comprised three components. First, product feasibility analysis used descriptive percentage (NP = R/SM × 100%) classified as very feasible (86–100%), feasible (68–85%), moderately feasible (51–67%), or not feasible (≤50%) (Purwanto, 2017). Second, engagement analysis employed descriptive statistics to compare mean engagement scores between groups across the three dimensions (behavioral, emotional, cognitive), followed by an independent samples t-test with exact p-values and 95% confidence intervals reported. Cohen's d effect sizes with 95% confidence intervals were calculated for each dimension. Third, learning outcomes analysis proceeded through: (a) normality testing using the Shapiro-Wilk test (Razali & Wah, 2011); (b) homogeneity of variance testing using Levene's test; (c) one-way Analysis of Covariance (ANCOVA) as the primary analysis, with posttest scores as the dependent variable, group as the fixed factor, and pretest scores as the covariate(Field, 2018; Tabachnick & Fidell, 2019).

ANCOVA was preferred over a repeated measures (within subject) analysis of variance for three principal reasons that are particularly germane to the present quasiexperimental design with intact, nonrandomised classroom groups. First, repeated measures ANOVA presumes baseline equivalence to yield an unbiased estimate of the treatment effect, an assumption that cannot be guaranteed in nonrandomised designs. ANCOVA, by contrast, statistically removes any residual baseline discrepancy through covariate adjustment, yielding the unbiased between group estimate that is the desideratum here (Dimitrov & Rumrill, 2003; Van Breukelen, 2006). Second, ANCOVA achieves substantially higher statistical power than repeated measures ANOVA whenever the correlation between pretest and posttest scores exceeds approximately 0.4, a threshold typically met in cognitive achievement research and confirmed in the present data. This power increase occurs because the covariate absorbs between subject variance that would otherwise inflate the error term (Maxwell et al., 2017; Tabachnick & Fidell, 2019). Third, ANCOVA directly yields adjusted (estimated marginal) means that quantify the between group treatment effect at the grand mean of the covariate.

This corresponds precisely to the substantive research question regarding the effect of the Monopoly game developed for Android on posttest outcomes for students of equivalent baseline ability. Repeated measures ANOVA partitions variance into between subject and within subject sources without producing a covariate adjusted contrast between groups and is therefore less informative for the present research question (Field, 2018); (d) independent samples t-test as a supplementary analysis with exact p-values

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and 95% confidence intervals; (e) normalized gain (N-gain) following Hake's formula and classification (Hake, 1998); and (f) Cohen's d and partial eta squared (η^2p) effect sizes with 95% confidence intervals (Cohen, 2013). All statistical analyses were performed using IBM SPSS Statistics version 27 (IBM Corp., 2020), with significance set at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Results

This section presents the findings of the study organized into three subsections: (1) the feasibility of the Android-based Monopoly game learning media as validated by experts, (2) the comparison of student engagement between the experimental and control groups, and (3) the comparison of learning outcomes including prerequisite tests, hypothesis testing, normalized gain analysis, and effect size calculation.

Media Feasibility

The results of expert validation are summarized in Table 5.

Table 5. Results of Expert Validation on the Android-Based Monopoly Game

Nu	Validator	Score	Max Score	%	Category
1	Media Expert	58	64	90.63	Very Feasible
2	Subject Matter Expert	55	64	85.94	Feasible
3	Education Practitioner	56	64	87.50	Very Feasible
	Average	**56.33**	**64**	**88.02**	**Very Feasible**

Expert appraisals confirmed the application's high viability, yielding an average validation score of 88.02% "Very Feasible" (Purwanto, 2017) and robust inter-rater reliability (ICC = 0.882) (Koo & Li, 2016). Ratings across media, pedagogical, and content domains were consistently strong. After implementing the subject matter expert's directive to adapt the vocabulary for fourth-grade comprehension, a preliminary trial with eight students corroborated the media's usability. The users navigated the interface effortlessly and displayed marked enthusiasm. Ultimately, these systematic validation steps established the digital instrument's technical and operational readiness for the primary experimental phase.

Student Engagement

Student engagement was measured using a 20-item questionnaire. Both groups was administered to fill it following the instructional intervention. The survey utilized a 4-point Likert scale to evaluate three specific areas, namely behavioral (7 items), emotional (7 items), and cognitive engagement (6 items). The instrument demonstrated strong overall internal consistency, with a Cronbach's alpha coefficients of 0.87. It exceeded the acceptable threshold of 0.70 (Taber, 2018). The descriptive comparison of engagement scores between the experimental and control groups is presented in Table 6.

Table 6. Comparison of Student Engagement Scores Between Groups

Dimension	Exp. M	Exp. SD	Ctrl. M	Ctrl. SD	Mean Diff	t(60)	p (exact)	d [95% CI]
Behavioral	3.20	0.41	2.93	0.43	0.27	2.56	0.013	0.64 [0.13, 1.15]
Emotional	3.25	0.38	2.97	0.43	0.28	2.74	0.008	0.69 [0.18, 1.20]
Cognitive	3.18	0.39	2.93	0.42	0.25	2.46	0.017	0.62 [0.11, 1.12]
Overall	**3.21**	0.39	**2.95**	0.41	**0.26**	**2.59**	**0.012**	**0.65 [0.14, 1.16]**

Note: *Maximum score = 4.00. All p-values are exact (2-tailed) from SPSS 27 . d = Cohen's d with 95% CI.*

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As detailed in Table 6, the Android-based Monopoly game kept students significantly more engaged than traditional teaching methods. Overall, the experimental group achieved a noticeably higher mean engagement score (*M* = 3.21, *SD* = 0.39) compared to the control group (*M* = 2.95, *SD* = 0.41). An independent t-test confirmed this difference to be statistically significant, $t(60) = 2.59$, $p = 0.012$, with a medium overall effect size (Cohen's $d = 0.65$). Across all dimensions, the effect sizes consistently fell within the medium range based on Cohen's benchmarks (Cohen, 2013), proving the game's robust pedagogical value.

Learning Outcomes

Descriptive Statistics of Pretest and Posttest Scores

The descriptive statistics for both groups are presented in Table 7.

Table 7. Descriptive Statistics of Pretest and Posttest Scores

Group	N	Test	Mean	SD	Min	Max	% ≥ KKTP
Experimental	32	Pretest	49.22	9.84	30.00	67.50	15.63
(School A)	32	Posttest	68.69	9.15	47.50	87.50	65.63
Control	30	Pretest	48.58	10.12	27.50	65.00	13.33
(School B)	30	Posttest	63.31	9.42	40.00	80.00	43.33

Note: KKTP (Minimum Competency Criteria) = 65.

Despite comparable pretest baselines, the experimental cohort utilizing the Android Monopoly application achieved superior cognitive gains (M = 68.69, SD = 9.15) and a substantially higher minimum competency attainment rate (65.63%) than the conventional control group.

Normality Test

Prior to inferential analysis, the *Shapiro-Wilk* normality test was conducted on all score distributions at $\alpha = 0.05$. The results are presented in Table 8.

Table 8. Results of the *Shapiro-Wilk* Normality Test

Data	N	W statistic	df	α	Conclusion
Exp. Pretest	32	0.964	32	0.352	Normal
Exp. Posttest	32	0.958	32	0.241	Normal
Ctrl. Pretest	30	0.971	30	0.568	Normal
Ctrl. Posttest	30	0.966	30	0.432	Normal

Homogeneity of Variance Test

Table 9. Results of Levene's Homogeneity of Variance Test

Data	F	df	p	Conclusion
Pretest Scores	0.127	1, 60	0.723	Homogeneous
Posttest Scores	0.198	1, 60	0.658	Homogeneous

Levene's test confirmed homogeneous variances for both pretest and posttest scores ($p > 0.05$; Table 9), satisfying the equal-variance assumption for parametric testing.

As reported in Panel B of Table 10, the one-way ANCOVA, the primary inferential test revealed a statistically significant treatment effect on posttest performance after controlling for pretest ability, $F(1, 59) = 6.12$, $p = 0.016$, $\eta^2p = 0.094$, indicating a medium effect (Cohen, 2013). The covariate itself was highly significant ($F(1, 59) = 16.01$, $p < 0.001$, $\eta^2p = 0.213$), confirming the appropriateness of pretest adjustment. The estimated marginal means in Panel C show that, at the grand pretest mean of 48.92, the experimental group's adjusted posttest score exceeded the control group's by 5.02 points,

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with the 95% confidence interval [1.00, 9.04] excluding zero. The supplementary unadjusted *t*-test reported in Panel A converged with the ANCOVA conclusion ($t(60) = 2.279$, $p = 0.026$, $d = 0.58$, 95% CI [0.07, 1.09]), reinforcing the robustness of the treatment effect across analytical specifications.

Table 10. Comprehensive Comparative Analysis of Posttest Scores: Independent Samples t-Test, ANCOVA, and Estimated Marginal Means

Statistical Component	Exp. (n=32)	Ctrl. (n=30)	Difference [95% CI]	Test Statistic	p	Effect Size [95% CI]
Panel A. Independent Samples t-Test (Unadjusted) — Supplementary Analysis						
Observed Mean (SD)	68.69 (9.15)	63.31 (9.42)	5.38 [0.66, 10.10]	t(60) = 2.279	0.026	d = 0.58 [0.07, 1.09]
Panel B. One-Way ANCOVA (Pretest as Covariate) — Primary Analysis						
Pretest Covariate Effect	—	—	—	F(1, 59) = 16.01	< 0.001	η^2p = 0.213
Group Effect (Treatment)	—	—	—	F(1, 59) = 6.12	0.016	η^2p = 0.094 (Medium)
Panel C. Estimated Marginal Means (Adjusted at Pretest Grand Mean = 48.92)						
Adjusted Mean (SE)	68.52 (1.37)	63.50 (1.42)	5.02 [1.00, 9.04]	—	—	—

Note: Dependent variable = posttest score. Panel B (ANCOVA) is the primary inferential test; Panel A (t-test) is reported as an unadjusted robustness check. Adjusted means (Panel C) are estimated at the grand pretest mean (M = 48.92); the 95% CI for the adjusted mean difference [1.00, 9.04] excludes zero, confirming the ANCOVA group effect. All analyses computed in IBM SPSS Statistics v.27 with a = 0.05.

Normalized Gain (N-gain) Analysis

The normalized gain score (N-gain) was calculated for both groups to quantify the magnitude of improvement from pretest to posttest. The comparative results are presented in Table 11.

Table 11. Comparison of N-gain Scores Between Groups

Group	Pretest Mean	Posttest Mean	Gain	N-gain	Category
Experimental	49.22	68.69	19.47	**0.38**	Moderate
Control	48.58	63.31	14.73	**0.29**	Low

Note: N-gain interpretation: High (≥ 0.70), Moderate (0.30–0.70), Low (≤ 0.30) (Hake, 1998).

N-gain analysis demonstrated that the experimental Android Monopoly intervention yielded a moderate learning improvement (0.38), objectively surpassing the low cognitive gain (0.29) recorded in the conventional instruction cohort.

Effect Size

As detailed in Table 12, the effect size analysis yielded Cohen's d = 0.58, classified as a medium effect (Cohen, 2013). this effect size confirms that the Android-based Monopoly game provided a substantial, practical learning advantage over conventional instruction.

Table 12. Effect Size of the Android-Based Monopoly Game on Learning Outcomes

Comparison	Mean Exp.	Mean Ctrl.	SD pooled	Cohen's d	95% CI for d	Interpretation
Posttest	68.69	63.31	9.28	0.58	[0.07, 1.09]	Medium

Summary of Findings

Table 13 provides a consolidated summary of the study's key findings across all measured variables.

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Table 13. Summary of Key Findings

Nu	Variable	Experimental	Control	Significance
1	Media Feasibility	88.02% (Very Feasible)	–	ICC = 0.882 [0.547, 0.985]; 3 validators
2	Overall Engagement	M = 3.21, SD = 0.39	M = 2.95, SD = 0.41	t(60) = 2.59, p = 0.012; d = 0.65 [0.14, 1.16]
3	ANCOVA (Primary)	Adj. M = 68.52	Adj. M = 63.50	F(1,59) = 6.12, p = 0.016, $\eta^2 p$ = 0.094
4	T-test (Supplementary)	M = 68.69	M = 63.31	t(60) = 2.279, p = 0.026, 95% CI [0.66, 10.10]
5	N-gain	0.38 (Moderate)	0.29 (Low)	–
6	Effect Size (Learning)	d = 0.58 [0.07, 1.09]	–	Medium
7	% Meeting KKTP	65.63%	43.33%	–

Discussion

The Impact of the Android-Based Monopoly Game on Student Engagement

The findings suggest that the Android-based Monopoly game significantly enhanced student engagement across all measured dimensions (behavioral, emotional, and cognitive), with medium effect sizes ranging from d = 0.62 to d = 0.69. These results confirm that interactive mobile platforms can fundamentally transform how elementary students interact with learning materials. The magnitude of these effects is consistent with the moderate effect sizes (g = 0.504–0.782) typically reported in gamification meta-analyses (Bai et al., 2020; Zeng et al., 2024). Thus reinforcing the ecological validity of the present findings within the broader body of gamification research.

Emotional engagement showed the most prominent change (d = 0.69), and the magnitude of this effect is best understood when Self Determination Theory (Deci & Ryan, 2000) is interpreted not generically but in tight thematic dialogue with the specific learning content, namely the Indonesian Cultural Diversity module of the Phase B IPAS curriculum. The theory suggests that intrinsic motivation and positive affect arise when an instructional environment simultaneously satisfies the psychological needs for autonomy, competence, and relatedness. The present intervention satisfied each of these needs through pathways mediated by cultural content rather than solely by game mechanics. Autonomy was actualised through dynamic exploration of regional cultures driven by the learner. Instead of selecting specific provinces, each dice roll navigated students through diverse cultural categories on the game board, such as traditional houses, regional dances, and musical instruments. This gamified mechanic transformed the curricular content from a rigid sequence imposed by the teacher into an engaging cultural itinerary experienced and advanced independently by the player. Competence was actualised through immediate mastery feedback specific to the content. Every correctly identified traditional house, regional dance, traditional costume, or musical instrument was reinforced by an animated multimedia cue, allowing students to experience perceptible mastery of culturally authentic artefacts, providing a far more meaningful competence signal than abstract and decontextualised points. Relatedness was actualised at two levels concurrently. At the proximal social level, this occurred through collaborative play involving three to four players within each device that fostered peer interaction. At the distal cultural identity level, this was achieved through the shared celebration of the *Bhinneka Tunggal Ika* heritage of Indonesia, which positioned

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each student as a joint curator of their own cultural pride and that of their classmates. This dual relatedness, both interpersonal and sociocultural, likely amplified the emotional response beyond what generic gamification stimuli (for example, abstract leaderboards and decontextualised badges) would have evoked. In short, the thematic coupling of Self Determination Theory mechanisms with culturally specific Indonesian content provides a plausible mechanistic account of why the effect on emotional engagement was the largest of the three engagement dimensions, and it positions the present intervention as theoretically and pedagogically distinct from generic mobile Monopoly applications previously reported in the literature (Mohammed et al., 2024; Rayan & Watted, 2024).

The game-based intervention substantially improved behavioral engagement (d = 0.64). Structural mechanics, including interactive tiles and competitive scoring, increased student persistence and on-task behavior. This specific environment triggers "situational engagement" (Plass et al., 2015), confirming recent evidence that gamification effectively sustains focus in elementary education (Ruiz et al., 2024).

Cognitive engagement also demonstrated a moderate but meaningful gain (d = 0.62). Modifying this specific dimension is historically difficult (Fredricks et al., 2004). However, the application required students to advance by correctly answering questions regarding Indonesian Cultural Diversity. This condition forced a shift from passive review to active recall. Such a dynamic acts as "effortful retrieval" for memory consolidation (Roediger & Butler, 2011), while the competitive scoring inherently prompts metacognitive awareness and self-regulation (Zimmerman & Moylan, 2009).

An important methodological caveat is warranted regarding the engagement findings. Because engagement was measured only at posttest using a context-specific questionnaire, the present results reflect between-group differences in engagement under different instructional conditions rather than within-group changes attributable to the treatment. The absence of pretest engagement data means that the possibility of pre-existing differences in engagement dispositions between the two intact classroom groups cannot be definitively excluded, even though comparable pretest learning outcomes provide indirect evidence of baseline equivalence. Accordingly, the engagement findings should be interpreted as demonstrating that students in the game-based learning condition reported significantly higher engagement than students in the conventional condition, rather than as definitive evidence that the game was associated with higher reported engagement from a prior state. This interpretive distinction is critical for maintaining the inferential integrity of quasi-experimental designs (Shadish et al., 2002) and aligns with best practices in engagement measurement, which recognize that context-dependent engagement states are most validly assessed within the specific instructional context under investigation (Fredricks et al., 2004; Sinatra et al., 2015).

The Impact of the Android-Based Monopoly Game on Learning Outcomes

The experimental intervention showed a statistically significant posttest advantage (p = 0.026), demonstrating a moderate effect size (Cohen's d = 0.58) that aligns with established meta-analytic benchmarks for educational gamification (Bai et al., 2020; Zeng et al., 2024). Because baseline scores were equal across cohorts, the superior learning growth observed in the experimental group (N-gain = 0.38 vs. 0.29) is directly attributable to the Android-based media. This trajectory supports previous findings regarding mobile game efficacy in elementary contexts (Dorris et al., 2024; Mohammed et al., 2024).

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Beyond statistical differences, the practical value of the game is evident in competency attainment. Mastery rates (KKTP ≥ 65) in the experimental group increased substantially from 15.63% to 65.63%, outperforming the control group's final rate of 43.33%. Such a distinct shift illustrates how interactive mobile learning can effectively enhance passing rates within a low-performing classroom. This outcome provides a scalable model for practitioners targeting instructional quality and educational equity in social studies (C.-C. Chen & Huang, 2023; Crompton et al., 2019).

Theoretical Mechanisms Underlying the Findings

The observed cognitive improvements are in accordance theoretically with Piaget's concrete operational stage (Piaget, 1973) and Dale's Cone of Experience (Dale, 1969). Children aged 9 to 11 typically struggle with abstract verbal instruction (Santrock, 2021); they require tangible learning methods to process information effectively (Aini et al., 2025). The Android-based Monopoly application directly accomodates this developmental requirement. It transforms theoretical concepts into interactive digital formats, which allowing students to manipulate touchscreen elements like regional dances and traditional houses. By integrating visual, auditory, and tactile stimuli, the intervention functions firmly within the multimedia tier of Dale's Cone (Dale, 1969; Davis & Summers, 2015). This multisensory engagement ultimately offers a stronger foundation for knowledge construction than conventional, textbook-reliant approaches.

Furthermore, the relationship between engagement and achievement we found in this study is consistent with a mature theoretical hypothesis that engagement mediates the influence of instructional design on learning outcomes (Christenson et al., 2012; Fredricks et al., 2004). The higher level of engagement of the experimental group over all three dimensions (i.e., behavioral, emotional, and cognitive) likely acted as an underlying mechanism that allowed the Android-based Monopoly game to achieve better learning results. Students when behaviorally involved, emotionally engaged, and cognitively strategic, expend more of their attentional resources to the learning material, process information at a higher level, and consolidate knowledge more successfully (Sinatra et al., 2015). This engagement–achievement relationship is further complemented in a meta-analysis of game-based learning in early childhood education (Alotaibi, 2024), which also showed that both engagement and cognitive outcomes yielded moderate-to-large effect sizes, emphasizing the functional interdependence of these constructs as opposed to their independence.

Limitations and Directions for Future Research

It is important to acknowledge several potential confounding factors that may have influenced the observed results. First, the present design cannot entirely rule out the novelty effect, a phenomenon where students exhibit heightened engagement and performance simply due to exposure to an unfamiliar instructional medium (Clark, 1983). However, several converging lines of evidence substantially mitigate this concern. Regarding intervention duration, the four-session program exceeds the typical window of one to two sessions during which engagement driven by novelty peaks and decays (Dichev & Dicheva, 2017). Because data collection occurred at the end of the fourth session, initial excitement should have substantially attenuated. This argument is further reinforced by measurement triangulation. Improvements emerged not only on self-reported engagement instruments, which are highly susceptible to novelty inflation, but also on an expert-validated cognitive achievement test (KR-20 = 0.904) that remains

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comparatively insensitive to short-term affective arousal (Roediger & Butler, 2011). Furthermore, an analysis of effect sizes supports this conclusion; the observed outcomes (d = 0.58 for learning outcomes; d = 0.65 for engagement) fall within the moderate range reported in gamification meta-analyses, suggesting the absence of markedly inflated estimates that would be expected if novelty alone were driving the gains (Bai et al., 2020; Sailer & Homner, 2020; Zeng et al., 2024). Finally, the construct alignment evident in parallel improvements across cognitive engagement (d = 0.62) and cognitive achievement indicates active effortful retrieval rather than mere affective stimulation (Roediger & Butler, 2011; Zimmerman & Moylan, 2009). Nevertheless, future replications should incorporate longitudinal follow-ups and delayed retention testing to definitively separate residual novelty from the durable pedagogical contribution of the game (Sailer & Homner, 2020).

Second, the engagement measure was only used during posttest. Although methodologically defensible for state-like, context-specific constructs (Fredricks et al., 2004; Sinatra et al., 2015), this approach necessarily limits trajectories of engagement change to a between-persons paradigm and carries with it the risk that between-group differences in engagement a priori exist due to pre-existing group differences in dispositions towards engagement. While pretest equivalence was observed in learning outcomes, pretest does not necessarily imply equivalence on engagement-related variables. Some suggestions for future research would be to include a pre-post measurement of more general dispositional engagement at baseline, compared to a context-specific and game-based measurement of engagement (posttest) such as the one used in this study, or using experience sampling methodology (Weerdt et al., 2024) to measure the time-variant nature of engagement over the course of game-based learning sessions.

Third, because the experimental and control groups were taught by their respective classroom teachers rather than a single instructor, teacher effects represent a potential confound. Differences in teaching style, enthusiasm, classroom management, or content delivery between the two teachers may have contributed to between-group differences beyond the treatment itself. While both teachers followed identical curriculum content over the same instructional period, and both schools were purposively selected for comparable characteristics, the absence of teacher randomization or crossover means that treatment effects and teacher effects are partially conflated (Shadish et al., 2002). The medium effect sizes obtained in this study are reassuring in this regard, as inflated effects from uncontrolled teacher variables would more likely manifest as implausibly large effect sizes (Kraft, 2020). Nevertheless, future research should employ crossover designs or deploy multiple teachers per condition. To minimise teacher-driven variance in subsequent replications, we propose a five-step standardisation protocol. First, a fully scripted lesson plan should be developed in which verbatim teacher utterances are specified at critical instructional moments (opening, instruction-giving, scaffolding of game mechanics, debriefing, and formative-assessment prompts), accompanied by a teacher manual that explicates the pedagogical philosophy of game-based learning under the *Kurikulum Merdeka*. Second, mandatory pre-implementation teacher training of no fewer than eight contact hours should be conducted, comprising hands-on rehearsal of the Android application, role-play of the scripted lesson, and contingency drills for predictable technical disruptions (e.g., connectivity loss, device sharing, group conflict). Third, a fidelity-of-implementation checklist should be administered by independent

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observers at every instructional session, with an a-priori target of at least 90 % adherence; sessions falling below this threshold should be flagged for sensitivity analysis. Fourth, all sessions should be audio- or video-recorded and a randomly selected 25 % subsample should be double-coded for inter-observer agreement, with a target Cohen's $\kappa \geq 0.80$. Fifth, subsequent analyses should incorporate a teacher-as-random-effect term within a multilevel (hierarchical) model so that any residual teacher variance can be statistically partitioned from the treatment variance, thereby disentangling instructional-medium effects from instructor effects within a single inferential framework. Collectively, these five steps would convert the present quasi-experimental contrast into a methodologically tighter test of the medium itself rather than of the medium-plus-instructor confound.

Fourth, the study was carried out in one sub-district and had a small sample size (N = 62), which restricts generalizability to wider populations or different cultures. The external validity of these findings would be improved with a multi-site replications across a wide variety of Indonesian regions and subject domains. Fifth, the present study did not test retention of learning gains over time. It would be useful also to investigate whether the effects of learning games last weeks or months, providing key evidence of the lasting effects of this intervention (Sailer & Homner, 2020).

Future randomised controlled studies should also adopt a dismantling (component-isolation) design to disentangle the contribution of distinct gamification mechanics that are presently bundled within the Android-based Monopoly application. Specifically, we propose isolating the following five mechanics in factorial or successive-additive trials: (1) the point-and-reward scoring system, hypothesised to drive extrinsic motivation and behavioural engagement; (2) the digital board-traversal mechanic (dice-rolling and territorial progression), hypothesised to elicit situational interest and sustained on-task attention (Plass et al., 2015); (3) the question-tile retrieval-practice mechanic, hypothesised to drive cognitive engagement and durable learning outcomes via effortful retrieval (Roediger & Butler, 2011); (4) the collaborative small-group play mechanic (three to four players per device), hypothesised to satisfy the relatedness component of Self-Determination Theory (Deci & Ryan, 2000); and (5) the multimedia-feedback mechanic (animated and culturally specific audio-visual reinforcement of correct responses), hypothesised to operationalise the multisensory tier of Dale's Cone of Experience (Dale, 1969; Davis & Summers, 2015). Implementing the proposed dismantling design, for example, through a 2^5 fractional factorial Randomised Controlled Trial (RCT) or a successive-additive RCT in which mechanics are introduced one at a time across waves, would enable each mechanic's main effect, its interactions with the others, and its differential contribution to behavioural, emotional, and cognitive engagement to be quantified independently of the bundled treatment effect. Such evidence would yield actionable design knowledge for the next generation of mobile game-based instructional media.

CONCLUSION

Fundamental Finding: The result of this study confirms that an Android-based Monopoly game that combines gamification with mobile technology improves student engagement and learning achievement of elementary social studies. In particular, the developed media shown to be feasible (88.02% validator, ICC = 0.882) and was effective in improving cognitive achievement, indicated by significant posttest score higher after controlling the initial ability (p = 0.016, Cohen's d = 0.58) and fourfold increase in the proportion of students meeting the minimum competence criteria. Moreover, the mobile interactive medium promoted significantly higher levels of behavioral, emotional, and cognitive engagement than the traditional lecture-based format. **Implication:** From a theoretical perspective, this study contributes to the growing body ofresearch on game-based mobile learning by revealing that interactive culturally contextualized gamification can simultaneously address multi-dimensional engagement and cognitive success. This also means that practically, the study provides implementable findings for elementary teachers, curriculum developers, and policymakers who are looking for the operationalization of student-centered principles of *Kurikulum Merdeka* in Indonesia. **Limitation:** The principal boundaries of this study are its small single-district sample (*N* = 62) drawn from intact, non-randomised classrooms, and its bundled treatment design, which precludes attribution of effects to individual gamification mechanics in isolation. **Future Research:** Subsequent investigations must prioritize rigorous randomized controlled trials and longitudinal retention tracking. Adapting this intervention framework across broader demographics and diverse academic disciplines will definitively establish its empirical boundaries.

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